THE IMPORTANCE OF HERDAGE IN POULTRY MANAGEMENT

by

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B. S., Kansas State College
of Agriculture and Applied Science, 1934

A THESIS

submitted in partial fulfillment of the

requirements for the degree of

MASTER OF SCIENCE

Department of Poultry Husbandry

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1939

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INTRODUCTION

During the last decade, grasses have received considerable scientific investigation, consequently much new information is now available concerning the utilization of grass and its by-products for animal food. Most of the credit for this work should go to the investigators in Europe who were among the first to realize the necessity for grass husbandry. Workers in this country have been responsible for many recent advances, especially concerning the utilization of grass by various animals. The problem reported herein deals with the economic importance of cereal grasses and alfalfa in poultry management.

It is only within recent years that poultrymen have realized the value of the grasses in poultry nutrition. Heretofore, emphasis was placed on the need for succulence in poultry rations as furnished by sprouted grasses and tubers, but lately the trend has been toward the use of green crops which furnish an abundance of vitamins A and G. Some of the better known green crops are alfalfa, clover, rape, kale, lettuce, bluegrass, and the cereal grasses. Of this last group oats, barley, Sudan, wheat and rye are among the better adapted types. The adaptability of these crops to the

prevailing climatic and soil conditions would determine their use in various parts of the country.

Chickens have probably utilized herbage in their diet in one form or another, ever since their origin. Beebe (1926) relates that the Junglefowl, progenitor of present day poultry, consumes large quantities of tender young shoots of bamboo and other grasses as a source of green food. Poultrymen of two centuries ago also realized the value of plant life in poultry rations. Reaumur (1750) stated "A vast deal of food our fowls borrow from plants that grow spontaneously and without culture, from all sorts of grasses and from the other plants of our green plots." Bonnet (1850) wrote, "Almost all kinds of green food are acceptable to poultry, and indulgence in this kind of diet is absolutely indispensable to their health, and is also advantageous in an economical point of view." Marcellus (1914) states "That green food of some kind is absolutely essential for the most economical returns in poultry keeping is believed to be true by practically everyone--yet the fact remains that there is little or no data available proving this to be the case."

Payne (1937) wrote, "Grasses are rich in the carotenoid

pigments, protein, minerals, and vitamins A, B, E and the G complex. - - - - There is probably no other single ingredient in the poultry diet which can be supplied as economically and which will add as much to the health, growth, and reproduction as will grass."

Grasses reach their maximum nutritive value at about the first jointing stage. At this time, Maynard (1937) explains that the tough, coarse fibrous materials have not formed and the grass is more easily digested than if it were mature. The reason is due to both the chemical and physical structure and particularly to the presence of certain encrusting substances, notably lignin, which are deposited in the cell wall with age. Microorganisms have little or no action on lignin particularly in mature plants, but more important is the fact that lignin protects the cellulose and other complex carbohydrates against the action of enzymes and the microorganisms.

Atkeson, Peterson, and Aldous (1937) studied thirteen typical Kansas pasture plants for their carotene analysis at various seasons of the year. They found, in general, relatively high carotene values in early summer, a marked decrease during the hot summer months, and an increase after the fall rains to somewhat near the early summer levels.

Miller (1933-34), working with several varieties of winter wheat, showed a wide variability of protein content at different stages of plant growth. A maximum of nearly 35 per cent crude protein was reached during the first four weeks of growth. The protein content of grasses will vary considerably depending upon the rate of growth and fertility of the soil on which the grass was grown.

Numerous workers including Archibald et al (1932, 1933, 1935), Newlander et al (1933), and Watson and Horton (1936) have made extensive investigations concerning the chemical composition of the grasses. Their analyses showed the presence of several readily available minerals including calcium, phosphorus, magnesium, potassium, copper, manganese, iron and many others of lesser importance in the grasses. The quantity and quality of the minerals in the various grass plants is dependent on the season of the year, soil conditions and varietal differences.

The fact that the active principle of grasses is soluble in the plant juices was pointed out by Kohler, Elvehjem and Hart (1938). They used the juices from centrifuged immature grasses to feed rats and guinea pigs and succeeded in obtaining improved growth. Whether this potency of the "grass juice factor" is applicable to poultry remains to be determined.

The high nutrient content of green feeds can be preserved for future feeding to poultry in several ways. Swanson and Tague (1917) used molasses and water to preserve alfalfa silage. The chemical process involved in this ensiling process was the action of bacteria on the sugars of the plant to form acids which prevent protein decomposition. Since most high protein green feeds are deficient in acid-forming materials, the addition of molasses was necessary to provide sugar for the bacterial action. Virtanen (1933) discovered in 1925, another effective method of ensiling green feeds. Previous investigations had shown that neither plant cells nor anaerobic microorganisms contained proteolytic enzymes that were active below pH_4. However, a pH below 3 would result in a silage containing an acidity that would be physiologically injurious when fed to animals. Thus, by treating fodder at the time of ensiling with such amounts of mineral acid as would rapidly raise the acidity of the mass to a point between pH_4 and pH_3, good silage could be made. This process was perfected in 1928 and patented as the A. I. V. Method (A. I. Virtanen).

The use of extremely high temperatures in artificially curing of green feeds has received considerable attention in recent years. Quick dehydration at higher temperatures inhibits enzyme activity and prevents oxidation of carotene.

Miller and Bearse (1934) showed that meals from dehydrated alfalfa or grass were usually appreciably higher in carotene content than meals ground from normal sun-cured hays. They also demonstrated that their dehydrated grass contained as much vitamin A as dehydrated alfalfa, but that dehydrated grass lost its potency more rapidly than the alfalfa. These dehydrated meals must be stored at low temperatures in order to reduce oxidation of the carotene content. By adding lactic acid in the form of condensed buttermilk to the dehydrated grasses, most of the carotene content can be retained. This process had recently been patented and the product is now sold as "Greenmelk" by the American Butter Company of Kansas City, Missouri.

Not all results of feeding greens to poultry are beneficial. The consumption of large quantities of greens usually results in the production of dark-colored egg yolks. "Grass eggs" in the spring of the year are occasionally found and are discriminated against by the buying public. Many investigators have studied the problem, most of whom have concluded that the xanthophylls, lutein from green leaves and xeaxanthin from corn, are responsible for the yellow color in the egg yolk. Just what causes the olive or greenish yolk color is unknown. Not all sources of green feeds produce the same results. Payne (1925) found that

pennycress and shepherd's purse, when fed to laying hens, did cause olive yolks. Berry (1938) obtained spotted or mottled olive colored yolks from hens ranging on green alfalfa during the winter months. Heiman and Wilhelm (1937) found that alfalfa, lawn clippings and kale when fed to laying hens produced much darker egg yolk color than did carrots. The latter ingredient caused little, if any, change in color since they contain only very small amounts of xanthophyll.

The economical benefits derived from feeding grass to poultry have been shown by several workers. Thomas (1933), Weinmiller (1936) and others show that consumption of albuminous feeds is reduced without a correspondent reduction in growth and egg production when birds have access to succulent green feeds. Heywang (1933) found that sun-cured alfalfa meal was a poor substitute for fresh alfalfa and that the latter was of great value in maintaining life when supplemented with cod liver oil at a level of 1½ per cent of the feed intake. Long (1936) compared the effect of feeding green cabbage, carrots, sprouted oats, ensilaged grass and ground lucerne hay on laying and breeding hens. In addition he substituted skim milk for green food but found it was more desirable to have ranging facilities. Especially was this true in the case of the breeding hens. Bearse (1938)

fed 3 duplicate lots of Leghorn pullets for twelve 28-day periods on dehydrated alfalfa, green feed, and green feed plus dehydrated alfalfa. The green feed in this instance consisted of kale for 3 periods, carrots for 3 periods, and lawn clippings for 6 periods. He concluded that succulent green feed did not improve egg production, size, albumen quality, adult mortality, body weight, or reduce feed consumption and that dehydrated alfalfa did give more uniform yolk color. In another study, Bearse (1938) compared the effect on hatchability, chick mortality and chick growth, of feeding 8 duplicate lots of breeding hens various supplements to the 1937 Washington Breeder's Ration. His results indicated that the percentage hatch of fertile eggs was increased about 8 per cent by the addition of 5 per cent whey, condensed buttermilk or condensed buttermilk containing cereal grasses. Supplementing the breeder's ration with condensed buttermilk containing cereal grasses did not improve hatchability over supplementing with straight condensed buttermilk, indicating the increase in hatchability was due to milk and not to grass. It should be stated, however, that the ration used already contained 10 per cent of a good grade commercial dehydrated alfalfa and that any improvement on the part of the cereal grasses was probably curtailed by the alfalfa. The growth, mortality and feathering were not improved by the additional supplements.

Berry (1938) concluded after 4 years observations on White Leghorn hens fed various types of green feed, that alfalfa was superior to cereal grasses as a year-around range crop. The hens ranging on alfalfa had lower adult mortality, produced more eggs and had a greater income above feed costs. Sudan grass was used during the summer and winter wheat during the cooler months as range crops for one lot and in another lot sprouted oats as a substitute for grass during the winter months. No mention is made of the stage of maturity of the grasses at the time of feeding, but it should be remembered that only young, tender, immature grass imparts beneficial results to growing poultry and that old, tough, wiry plants are of little value as poultry feed. Numerous workers and practical poultrymen have long since given up the use of sprouted oats as a nutritious green food for poultry.

All of Berry's work was based on adult birds alone and no consideration is given to the effect of various green foods on the growing chick. It is quite possible and highly probable that early chick nutrition influences the adult performances.

Since there has been a large difference of opinion concerning the utility of green foods in poultry rations, it seemed desirable to further study the problem from two phases: first, to determine the value of fresh cereal

grasses in promoting desirable growth, livability and vigor in chicks; second to study the effect of cereal grasses, dehydrated alfalfa and condensed buttermilk on pullets during their first production year as measured by egg size, number laid, hatchability, feed consumption, livability and cost of production.

MATERIALS AND METHODS

Part I. Brooding and Rearing of Chicks

The problem covered a period of seventy-six weeks, starting April 7, 1937, and continuing through September 20, 1938. Thirteen hundred and ninety-four Single Comb White Leghorn chicks were hatched in two groups, April 7 and 14, 1937, for this problem. The dams and sires were pullets and cockerels of good production strains maintained on the experimental plant of the Poultry Department at Kansas State College. The chicks were divided into 4 groups of 300 each and one of 194 and toe-marked for future identification. The first 4 groups were started under 56" Lyon electric hovers located in 10' x 12' colony brooder houses. The hovers were held at a temperature of 95° F. for the first week after which it was reduced gradually and finally discontinued when the birds were 8 weeks old. Each brooder house had sanitary runways in front. These houses were lo-

cated on land belonging to the Animal Husbandry Department, and as far as could be ascertained, chickens had never been raised there before. The ground previously had been seeded to rye and used for wintering sheep, and at the time the chicks were moved out, a good stand of rye remained. During the early summer, several seedings of Sudan grass were made for shade and summer pasture, however, due to lack of moisture the grass did not make normal growth. When the chicks were one week old they were allowed to use the sanitary runways and at 4 weeks of age were given restricted range on the ground.

All chicks received the following (mash and grain) rations throughout the rearing period:

Mash Feed	1-6 wks.	7-24 weeks
Ground yellow corn	20	20
Ground wheat	20	20
Ground oats	20	20
Wheat bran	11	15
Dehydrated alfalfa leaf meal	10	5
Meat meal	7.5	7.5
Fish meal	7.5	7.5
Tobacco dust	0	2
Ground oyster shell	2	2
Salt	1	1
Biotol	1	0
	100	100

Scratch grain consisting of equal parts of cracked yellow corn and whole wheat was fed when the chicks reached 3 weeks of age.

The chemical analysis of the above ration was:

	Protein	Fat	Fiber	N.F.E.	Moisture	Ash	Calcium	Phosphorus
Calculated	20.85	4.2	6.96	48.37	--	--	1.68	.80
Actual	21.19	5.1	6.34	50.84	7.22	8.95	1.87	.85

In addition to the above ration, the chicks on the grass range received liberal amounts of freshly cut green chopped oats fed daily from 7:30 to 8:30 a. m.

The work was divided into 6, 4-week periods. Group weights and feed consumption records were made at the start and finish of each period. Daily observations on condition and general health of the birds were obtained. Dead and ailing birds were frequently taken for autopsy to the Department of Bacteriology, Kansas State College. Retail feed prices for the ingredients used in the rations throughout the entire experiment were obtained from the Farmers Co-operative Elevator Association of Manhattan. The costs of the rations were computed at the finish of each period.

A total of 84, 8-week old cockerels were selected and dubbed for future breeding stock. They were kept with the pullets throughout the remainder of the brooding season.

All other cockerels whose sex could be determined at 8 weeks of age were removed from the experiment and disposed of. Feed consumption records were kept on the males held over as if they were pullets although they were weighed separately.

The remaining group of 194 chicks was started in battery brooders located in a steam heated room held at a temperature of 90° F. After one week they were moved to another room which was 10 degrees cooler for a two week period. At 3 weeks of age, the birds were again moved to a brooder house and confined to an 8' x 10' room, where they had access to heat from a 42" Lyon electric hover. At 8 weeks of age, they were weaned from heat and moved to a 10' x 12' colony brooder house located on alfalfa range where they stayed throughout the remainder of the rearing period. This range was occupied the year before and was crowded during the period the control chicks used it. It was the intention to rear this lot of birds in a manner and place similar to the general procedure of the remainder of the farm poultry. They were not true controls, although they may be referred to later as such, but were used only for the sake of comparison.

Feed records of the control group were not maintained after the eighth week because other poultry were using the same feeding facilities on the alfalfa range thus preventing accurate weights.

Part II. The First Laying Year

Three hundred of the best pullets from the grass range were selected at random and placed in a laying house in three equal groups, lots I, II and III. Seventy-five pullets from the control group and 25 additional pullets from the same strain but of a different hatch were selected for lot IV. Eight dubbed cockerels from the same flocks were placed in each lot at the start of the experiment and removed on April 20, 1938. All birds were individually weighed three times during the experiment, i. e., at the start or 24 weeks of age, at 46 weeks and at 76 weeks or one year after the start. Each of the four groups was housed in a 20' x 20' section of a 20' x 80' Kansas type open front straw loft house. The birds were confined to the house from the start of the experiment until April 24, 1938, at which time lot II was turned out on oats and later Sudan grass pasture while lots I, III and IV were turned on bare ground of equal size. The following rations were hopper fed free choice style. Lots III and IV received these same rations, the only difference between these two being the type of green feed consumed during their brooding and rearing period and the variation in brooding and management noted above.

	Lot I	Lot II	Lot III	Lot IV
Ground yellow corn	20	20	20	20
Ground wheat	20	20	20	20
Ground oats	20	20	20	20
Wheat bran	10	10	10	10
Dehydrated alfalfa leaf meal	0	0	5	5
Meat meal	4.5	5	4	4
Fish meal	4.5	5	4	4
Soybean oil meal	4.5	5	4	4
Argo corn starch	3.5	2	0	0
Salt	.5	.5	.5	.5
Nopco XX[1]	.5	.5	.5	.5
Condensed buttermilk	0	0	12	12
Greenmelk	12	0	0	0
Cereal grasses and oat silage	0	12	0	0
Total	100	100	100	100

In addition to the above rations, whole grains consisting of yellow corn and wheat and oyster shell were hopper fed. Daily feedings of the supplements were as follows:

Lot I	3 pounds Greenmelk per 100 birds
Lot II	4 pounds chopped oats, oats silage or Sudan grass per 100 birds
Lots III and IV	3 pounds condensed buttermilk per 100 birds

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1. The use of cod liver oil in the mash was discontinued June 29, 1938.

The amount of supplement fed per day was decreased proportionately as the number of pullets decreased.

The chemical analyses of the mash mixtures as determined by the Chemistry Department of Kansas State College were:

	Lot I	Lot II	Lots III and IV
Protein	18.50	19.88	18.81
Fat	4.11	4.14	4.04
Crude fiber	6.37	6.75	7.36
Moisture	10.15	9.72	9.77
Ash	5.33	5.58	5.65
N. F. E.	55.54	53.93	54.37

The vitamin A content was calculated on each of the three rations, using U. S. P. units as shown in Table 1. All three rations had an abundance of (calculated) vitamin A.

Table 1. The calculated vitamin A content of rations fed.

Ingredient	Lot I		Lot II		Lots III and IV	
	Amt. fed	Units	Amt.fed	Units	Amt. fed	Units
Mash	30	339,600	30	337,200	33.3	644,000
Grain	58 (9 corn, 49 wheat)	57,150	58	57,150	66.7 (10.4 corn, 56.3 wheat)	66,040
Supplement	12	470,400	12	512,400	0	--
Total	100	867,150	100	906,750	100	710,040
Per lb. of ration		8,671.5		9,067.5		7,100.4
Minimum requirements		2,043.0		2,043.0		2,043.0
Surplus		6,628.5		7,024.5		5,057.4

Feed consumption records were obtained at the close of each 4-week period. Feed costs were determined for the laying period by averaging the prices at the start and finish of each period. All birds were trapnested and the eggs individually weighed daily. The average straight run egg price for each period, as paid locally by the Perry Packing Company, was used to determine the egg receipts for each hen and lot. This method of determining feed costs and egg receipts is not a fair estimate of the flock's worth since a large majority of the eggs could be sold for a higher price on a graded market and since a flock of this size would warrant purchase of feed in wholesale rather than at retail prices thus reducing the feed costs. It does, however, give a valid comparison of the methods of rearing and feeding.

All dead birds and those ailing which showed no signs of recovery were taken to the Department of Bacteriology for autopsy. The birds in the experiment were vaccinated June 30, 1937, for fowl pox with pigeon-pox virus. A very high percentage of takes was obtained.

All the birds were blood tested for pullorum by the whole blood tube agglutination method on December 21, 1937. The writer drew the blood samples while the Department of Bacteriology ran the tests. A very high percentage of reactors (26.2 per cent of all birds tested) was obtained. In

order to check these results, 137 eggs from 55 reactor pullets were incubated and then brooded for 24 days with a resulting 62.2 per cent hatch of fertile eggs set and 97.4 per cent livability. It was decided to retest all the birds by the rapid plate agglutination test (Salisbury antigen) at the farm and have these reactors and suspects rechecked by the tube method by the Department of Bacteriology. The results were similar to the first testing except for some increase in the number of reactors. Removal of all the reactor hens would have ruined the rest of the experiment so it was decided to retest twice more, by rapid plate method, all the previous non-reactors and hatch from the hens that showed no reaction whatsoever. The hazards of such procedure were recognized but no other solution seemed available.

A summary of the pullorum testing appears in Table 2.

Table 2. Results from pullorum testing.

Lot No.	1st test Bact. tube	2nd test Our plate		Bact. tube		3rd test Our plate	4th test Our plate	Total[1]
1	26	16	+1	16	+1	7	6	40
2	36	23	+1	24	+0	5	2	49
3	23	27	+3	27	+3	4	1	42
4	8	12	+3	10	+5	0	2	16
Total	93	78	+8	77	+9	16	11	147

1. Total number of reactors plus dead birds on which autopsy was previously made.

The low reaction in lot IV was probably due to an absence of infection during the brooding period.

This problem may be criticized for having too many variables. There was a lack of uniformity in the methods of brooding and ranging facilities of the chicks, and also in the choice of one-fourth the control pullets. The effect of these variables on the final results is debatable.

RESULTS

Part I. Results from Chicks

Growth and Feed Costs. Since the control group of chicks was not confined to itself while on range no feed consumption records were kept on this lot. This discrepancy prohibits the comparison of feed consumption and costs between the groups. Tables 3, 4 and 5 are self explanatory.

Table 3. Growth of grass-fed Leghorn chicks.

Age	Number chicks weighed		Total weight pounds		Average weight pounds	
	Females	Males	Females	Males	Females	Males
Day old	1200		107.620		.0896	
4 wks.	1099		439.057		.3995	
8 wks.	1050		1139.372		1.1327	
12 wks.	487	84	795.00	175.62	1.6324	2.091
16 wks.	465	79	986.05	216.13	2.1205	2.735
20 wks.	454	76	1139.85	256.00	2.5547	3.367
24 wks.	439	71	1347.05	270.56	3.0685	3.810
Total	439	71	1347.05	270.56	3.0685	3.810

Table 4. Feed consumption and cost of production of grass-fed Leghorn chicks.

Age	Av.no. of chicks	Feed consumed: Mash	Grain	Cost of feed consumed	Amt. feed cons. per chick	Lbs. of feed per lb. gain	Cost of production: Feed only
Day old	1200	0	0	0	0	0	0
4 wks.	1156.3	910.25	279.5	$ 30.73	1.03	3.324	.0266
8 wks.	1083.7	1175.50	1334.0	58.77	2.32	3.164	.0542
12 wks.	586.5	611.00	1311.5	42.63	3.28	4.499	.0727
16 wks.	552.9	532.00	1236.5	37.90	3.20	5.654	.0635
20 wks.	535.8	450.50	1352.0	34.56	3.36	6.303	.0645
24 wks.	515.4	545.00	1284.5	34.38	3.55	7.421	.0667
Total	515.4	4224.25	6796.5	238.97	16.74		0.3532

Table 5. Growth of control Leghorn chicks.

Age	Number chicks weighed	Total weight pounds	Average weight pounds
Day old	194	16.72	.0862
4 wks.	173	70.50	.4075
8 wks.	165	183.00	1.1091
12 wks.	80	134.19	1.6773
16 wks.	79	177.00	2.2405
20 wks.	73	194.00	2.6575
24 wks.	71	217.50	3.0633
Total	71	217.50	3.0633

There was no appreciable difference in the average body weights of the pullets in either lot, both weighing 3.06 pounds at 24 weeks of age. There was, however, material difference in favor of the grass-fed lot, in general appearance and thriftiness at this time. These birds were more mature, having started to lay at 133 days, had smooth, white feathering, dark yellow shanks and beaks, and were 100 per cent free from crooked keels. The control pullets showed less maturity, poor quality feathering, light yellow colored shanks and beak, and a high percentage (20.5) of crooked keels. The significant difference in crooked keels was probably due to methods and age of roosting rather than the kind of green feed consumed. The control birds were forced to roost at 8 weeks of age while the grass-fed lot were given access to roosts at the same age, but were not forced to use them.

Sixteen and three-fourths pounds of feed were required to raise each of the experimental pullets to 3.06 pounds and males to 3.81 pounds, or an average of 3.44 pounds for both sexes to 24 weeks of age. These figures are somewhat better than the standard established in 1918 by the Connecticut Agricultural Experiment Station as shown in Table 6.

Table 6. White Leghorns.

	Kansas		Connecticut[1]	
Age in weeks	Total feed consumed per chick	Av. weight of males and females	Total feed consumed per chick	Av. weight of males and females
4	1.03	.3995	.791	.367
8	2.32	1.1327	2.331	1.090
12	3.28	1.8616	3.760	1.795
16	3.20	2.4281	4.347	2.363
20	3.36	2.9615	5.438	2.898
24	3.55	3.4396	5.489	3.283
Total	16.74	3.4396	22.156	3.283

1. Taken from Conn. (Storrs) Agr. Expt. Sta. Bul. 96, June 1918.

Feed costs during the spring and summer of 1937 were comparatively high thus increasing the cost of producing each bird to maturity. No record was kept of the amount or cost of the green feed supplemented daily to the experimental group.

Table 7. Retail feed prices per cwt. for the first 24 weeks.

Ingredient:	4-7:	5-4 :	6-1 :	6-29:	7-27:	8-24:	9-21:	Average
Mash	2.48	2.62	2.50	2.36	2.13	1.97	1.95	2.28
Corn	2.30	2.90	2.85	2.50	2.30	2.30	2.25	2.48
Wheat	2.35	2.45	2.20	2.15	2.15	1.90	1.85	2.15

The cost of 35 cents per bird for grain feed consumed to 24 weeks of age is very reasonable in view of the high feed prices.

Mortality

An infectious cold appeared in both groups of chicks at about two weeks of age, causing severe losses. The ailing birds developed watery eyes which finally glued shut; they had difficult breathing and became droopy. Death was lingering in most cases although some appeared to die quite suddenly. Autopsies failed to reveal the cause or causes responsible for the infection. Potassium permanganate was added to the drinking water and sanitation measures practiced when the trouble first appeared. After about two weeks duration, the infection disappeared and no further losses from this trouble were experienced. Infestations of tapeworms and coccidia appeared in several of the birds during the summer but did not cause serious trouble. The mortality record showing the percentage and apparent cause of deaths for both groups for 24 weeks appears in Tables 8 and 9.

Table 8. Mortality, grass-fed Leghorn chicks.

Age	Dead							Culled					
	Colds and unknown	Paralysis	Cat	Cannibalism	Heat	Drowned	Miscellaneous	Small and thin	Tapeworms	Coccidiosis	Total		Percentage
Day old											1200		
4 wks.	99			2							101		8.42
8 wks.	8		6			1		8			23		1.92
12 wks.	2						1	5			8		.67
16 wks.	7						2	5		10	24		2.00
20 wks.	2				2		1		5	4	14		1.17
24 wks.	1	2			1				10	6	20		1.67
Total	119	2	6	2	3	1	4	18	15	20	190		15.83
Per cent	9.91	.17	.50	.17	.25	.083	.33	1.50	1.25	1.67	15.83		

Table 9. Mortality for control Leghorn chicks.

Age	Dead			Culled		Total	Percentage
	Un-known	Can-ni-balism		Small and thin	Tape-worms		
Day old						194	
4 wks.	21					21	10.82
8 wks.	5	3				8	4.12
12 wks.	1			1		2	1.03
16 wks.	1					1	.51
20 wks.	1			2		3	1.55
24 wks.					2	2	1.03
Total	29	3		3	2	37	19.07
Per cent	14.95	1.55		1.55	1.03	19.07	

The grass-fed lot showed a total mortality for 24 weeks of 15.83 per cent as compared to 19.07 per cent for the control lot. This represents a difference of 3.24 per cent in favor of grass as compared with alfalfa ranges. Mortality during corresponding periods for both groups was quite similar, being heaviest during the first four weeks and decreasing with age. The exact cause of death for all of the chicks during the first period was not ascertained but probably most of it was due to the previously mentioned infection. Several small emaciated birds were removed from both lots during the latter part of the brooding season.

Part II. Results from Pullets

Hatchability

Fifteen hundred and five eggs were set in a forced draft incubator from the four lots during April 1938, a total of 896 being hatched. This represented a hatch of 59.5 per cent of the total or 65.0 per cent of the fertile eggs set. No reason can be given for this exceptionally low hatch.

Table 10. Hatchability.

Lot No.	No. eggs set	Per cent fertile	No. vig. chicks	Per cent fertile egg hatch	Per cent total egg hatch
1	431	88.4	255	66.4 ± 1.63	58.7
2	371	94.3	225	64.3 ± 1.73	60.6
3	384	85.7	204	62.0 ± 1.80	53.1
4	319	95.0	214	70.6 ± 1.72	67.1
Total	1505		896		
Av.		90.5		66.0 ± .87	59.5

In order to obtain a better comparison of the hatchability results between lots, the error of the means for the percentage hatchability and the probable error of the difference were calculated as follows:

(a) Means for percentage hatchability

$$E_M = \sqrt{0.6745 \times \frac{P \times Q}{N}}$$

Where P = Percentage hatch
Q = Percentage not hatched
N = Number fertile eggs set

(b) Probable error of the difference

$$E \text{ (diff)} = \sqrt{E^2 (1) + E^2 (2)}$$

The comparisons given in Table 11 indicate no significant difference between any of the four lots since the differences are not more than four times their probable errors. The improved hatchability of eggs from the alfalfa raised lot as compared to the grass lots may have been due to the fact that excessive mortality in lot IV had previously removed the weak stock and consequently the poorer hatching hens.

Table 11. Differences and probable errors in the differences in hatchability of eggs from the four lots.

Lots	II	III	IV
I	2.1 ± 2.39	4.4 ± 2.43	4.2 ± 2.37
II		2.3 ± 2.49	6.3 ± 2.43
III			8.6 ± 2.49

Egg Production

Tables 12, 13 and 14 indicate the egg production per hen by periods, percentage production per lot by periods, and value of eggs sold per period.

Table 12. Egg production per hen by periods.

Time in laying house-wks.	Lots I	II	III	IV
4	5.64	4.79	4.27	5.38
8	15.19	13.18	13.35	13.95
12	14.20	15.02	12.39	9.83
16	12.51	14.05	11.03	9.76
20	15.06	13.60	12.08	11.61
24	16.12	14.04	13.58	14.29
28	17.68	17.15	15.58	16.99
32	17.24	16.43	15.35	16.84
36	16.17	14.81	13.84	14.46
40	12.70	12.48	10.73	13.81
44	10.33	9.12	9.42	11.60
48	8.94	9.17	9.26	12.17
52	8.67	9.29	9.18	8.89
Total	170.06	163.13	149.46	159.58

Table 13. Percentage egg production per lot by periods.

Time in laying house--weeks	Based on average no. hens Lots I	II	III	IV	Based on original no. hens Lots I	II	III	IV
4	20.1	17.1	15.2	18.8	20.1	17.1	15.2	18.9
8	54.2	47.1	47.7	49.8	53.5	46.5	47.0	45.8
12	50.9	53.7	44.2	36.1	48.4	50.1	41.6	28.3
16	55.3	50.2	39.4	34.9	50.4	45.3	35.2	23.4
20	53.8	48.5	43.1	41.5	47.8	43.2	38.3	23.4
24	57.6	50.2	48.5	51.1	48.9	42.5	38.9	25.7
28	63.1	61.2	55.6	60.7	49.2	48.3	42.4	28.4
32	61.6	58.7	54.8	60.2	44.5	43.5	37.8	25.1
36	57.7	52.9	47.3	51.6	39.7	36.1	30.3	18.3
40	45.3	44.8	38.3	49.4	29.9	27.6	23.1	15.7
44	36.9	32.6	33.7	41.4	23.2	19.3	19.3	11.4
48	31.9	32.7	33.0	43.4	18.3	18.1	17.3	9.4
52	31.0	33.2	32.8	31.8	17.2	17.7	16.0	6.3
Average	48.2	45.2	41.1	41.8	37.8	35.0	30.8	21.5

Table 14. Value of eggs sold per period.

Time in laying house--- weeks	Av. egg price--- cents per doz.	Lots I	II	III	IV
4	17.50	$ 8.23	$ 6.98	$ 6.23	$ 7.71
8	20.25	25.29	21.98	22.20	21.64
12	19.25	21.71	22.18	18.70	12.71
16	17.77	20.87	18.39	14.58	9.69
20	14.00	15.62	13.79	11.85	7.65
24	13.25	15.15	12.90	12.01	7.94
28	13.25	15.21	14.30	13.11	8.78
32	14.25	14.79	14.05	12.58	8.36
36	15.00	13.89	12.63	10.61	6.40
40	14.75	10.29	9.51	7.95	5.40
44	16.25	8.79	7.33	7.30	4.52
48	17.00	7.25	7.18	6.87	5.76
52	19.25	7.73	7.96	7.17	2.62
Average or total	16.29	184.80	169.19	151.16	107.16

Lot I led in egg production per hen with 170.05 eggs figured on the average hen day basis, followed by lots II, IV and III, with 165.13, 159.58 and 149.46 eggs respectively.

Statistical analyses of the egg production figures indicate positive significance in favor of lot I over II, III and IV; lot II over III; and lot IV over III. In arriving at this conclusion, the data were set up in a chi-square test similar to that used by Snedecor. Each of the lots was compared one with another, to determine its degree of homogeneity. Part of the error in the rate of laying of living hens was removed by eliminating the interval of days between the date of the last egg laid and the date of death, from

the total hen days of the birds dying during the experiment. A sample problem is shown in Table 15.

Table 15. Number of eggs laid in two lots of pullets. (Expected number in parenthesis)

Pen	Number days eggs laid	Number days no eggs laid	Total number hen days
1	13749 (13318)	14055 (14486)	27804
2	12745 (13150)	14709 (14304)	27454
Total	26494 (47.9%)	28764 (52.1%)	55258

$$(13749 - 13318)^2/13318 = 13.9$$
$$(14486 - 14055)^2/14486 = 12.8$$
$$(13150 - 12745)^2/13150 = 12.5$$
$$(14709 - 14304)^2/14304 = 11.5$$
$$\chi^2 = 50.7$$

Table 16. Chi-square values between all lots.

Lot	II	III	IV
I	50.7	236.1	59.3
II		69.1	2.2
III			54.4

All values for chi-square greater than 3.8 are significant, indicating a lack of homogeneity between the pairs of lots in question.

The highest percentage production by any one lot was 63.1 per cent reached by lot I during the seventh period or from March 9, to April 5, 1938. Receipts from eggs in each lot were in the same order as total production and average production, i. e., I, II, IV and III.

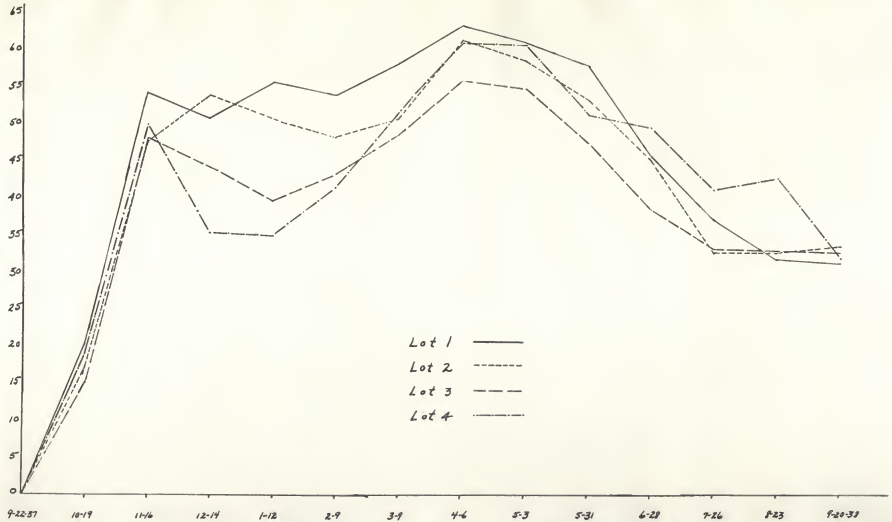

Figure 1. Percentage egg production at four-week intervals.

From Figure 1 it may be observed that pullets fed on Greenmelk and grass during their first laying year (lots I and II) did not have as severe a winter pause and were also able to overcome it in less time than pullets fed on alfalfa leaf meal (lots III and IV).

Egg Size

From Table 17 it can be observed that the egg size was quite similar for lots I, II and III (reared on grass range) but much lower in lot IV (reared on alfalfa range).

Table 17. Average size in grams of the first ten eggs laid in May.

Lot		
I	60.15	± .396
II	59.91	± .445
III	60.18	± .551
IV	57.47	± .504

Table 18 indicates a positive significance in favor of lot I over lot IV and questionable significance in favor of lots II and III over lot IV.

Table 18. Differences and probable errors of the difference in egg size from all four lots.

Lot	II	III	IV
I	.2470 ± .5957	.0292 ± .6786	2.6660 ± .6409
II		.2762 ± .7080	2.4390 ± .6718
III			2.7152 ± .7463

Feed Consumption

Table 19 shows the amount of feed (mash and grain) consumed per bird by 4-week periods and for the entire experiment. Lot I consumed the most with 80.43 pounds followed in order by lots II, IV and III with 77.01, 74.64 and 72.57 pounds respectively. It required 5.6 pounds of feed to produce one dozen eggs in lots I, II and IV, and 5.8 pounds for lot III.

Table 20 represents the summary of feed consumption by lots and the feed costs per hen. On an average, all birds consumed two-thirds wheat, one-third mash, and a small amount of corn of their entire ration. Lot II consumed less wheat, but more corn and mash than the other lots.

Feed Costs

Feed costs per hen for the year were in favor of lot II which was $1.385 with lots III, IV and I having $1.591, $1.637 and $1.869 respectively. The decrease in feed costs in lot II was due to the use of grass at one cent per pound and no milk, as compared to "Greenmelk" at 5 cents per pound in lot I and white milk at 4 cents per pound in lots III and IV. Table 21 indicates the average retail prices of feed used in the experiment for the entire laying year.

Table 19. Feed consumed per bird.

Time in laying house--weeks	Lots I Av. no. birds	I Tot. feed	I Av. feed lbs.	II Av. no. birds	II Tot. feed	II Av. feed lbs.	III Av. no. birds	III Tot. feed	III Av. feed lbs.	IV Av. no. birds	IV Tot. feed	IV Av. feed lbs.
4	103.5	691	6.67	104.0	584	5.62	104.0	578	5.56	102.9	550	5.34
8	106.6	627	5.88	106.8	615	5.76	106.5	615	5.77	99.8	564	5.65
12	102.1	627	6.14	100.4	645	6.42	101.1	604	5.97	87.6	488	5.57
16	97.3	573	5.89	96.5	634	6.57	95.8	599	6.25	72.5	445	6.14
20	94.9	672	7.08	95.1	639	6.72	90.1	605	6.60	60.7	379	6.24
24	91.4	651	7.12	90.8	645	7.10	85.6	578	6.75	54.3	357	6.57
28	83.9	599	7.14	84.9	538	6.34	81.2	501	6.17	50.8	347	6.83
32	75.3	520	6.91	77.3	500	6.47	71.5	354	4.95	43.8	281	6.42
36	68.7	459	6.68	68.2	425	6.23	64.1	388	6.05	35.4	215	6.07
40	65.9	396	6.01	62.0	344	5.55	60.3	310	5.14	31.8	161	5.06
44	62.8	311	4.95	59.3	266	4.49	57.2	270	4.72	27.5	150	5.46
48	57.3	279	4.87	55.3	258	4.67	52.4	248	4.73	21.7	101	4.65
52	55.6	283	5.09	53.4	271	5.07	48.7	239	4.91	19.8	92	4.65
Total		6688	80.43		6364	77.01		5789	72.57		4130	74.64

Table 20. Summary, feed consumption by lots.

Lot no.	Lbs. mash	Per cent mash	Lbs. wheat	Per cent wheat	Lbs. corn	Per cent corn	Total lbs. feed	Lbs. feed per bird	Lbs. shell	Total cost sup-ple-ment	Feed cost per hen
I	2373	36.0	3937	59.8	276	4.2	6588	80.43	289	$56.10	1.869
II	2378	37.4	3532	55.5	454	7.3	6364	77.01	281	116.68	1.385
III	1941	33.5	3731	64.5	117	2.0	5789	72.57	232	129.55	1.591
IV	1225	29.7	2825	68.4	80	1.9	4130	74.64	175	93.15	1.637
Av.		34.2		62.1		3.8					

Table 21. Summary of retail feed prices per cwt. From Farmers Co-operative Elevator Association, Manhattan, Kansas.

	Maximum price	Minimum price	Average price[1]
Ground corn	$2.05	$1.20	$1.38
Ground wheat	1.95	1.05	1.47
Ground oats	1.50	1.15	1.41
Bran	1.20	.80	1.04
Dehydrated alfalfa meal	1.80	1.53	1.72
Meat meal	2.75	2.28	2.49
Fish meal	3.63	3.25	3.45
Soybean oil meal	2.38	1.70	1.94
Starch	6.00	6.00	6.00
Salt	1.50	1.25	1.43
Oyster shell	.90	.85	.88
Nopco XX	.33	.33	.33[2]
Whole corn	1.95	1.10	1.28
Whole wheat	1.85	.95	1.37
Computed mashes per cwt.			
Lot I	2.31	1.51	1.84
Lot II	2.23	1.46	1.78
Lots III and IV	2.08	1.31	1.70
Supplements			
Greenmelk	5.00	5.00	5.00[3]
Condensed butter milk	4.00	4.00	4.00
Oat grass silage	1.00	1.00	1.00

1. Average of 13 quotations.
2. Cents per pound.
3. The price for the supplements was constant throughout the year.

The cost of producing oat grass and oat grass silage during the spring of 1937 was as follows:

Soil preparation, 3 acres	
Plowing, 3 hrs. at 1.25	$3.75
Harrowing, 5½ hrs. at .65	3.58
Seeding	
Smut treated seed oats, 9 bu. at .75	6.75
Drilling seed and rolling ground, 5 hrs. at 1.25	6.25
Total for 3 acres	$20.33
Per acre	6.78
Filling silo	
Teamster, cutting and hauling, 16 hrs. at .65	$10.40
Ensilage cutter and operator, 6 hrs. at 1.25	7.50
Miscellaneous labor, 34 hrs. at .30	10.20
Immature oat grass, 1.4 A. at 6.78	9.49
Molasses, 360 lbs. at .0135	4.86
Total for 1.4 A. or 4½ tons silage	$42.45
Per ton	9.43
Per pound	.0047

Figuring one cent per pound for immature oat grass and molasses oat grass silage would still leave .00529 per pound for rental on land and labor in feeding and incidentals. It would, therefore, seem that one cent per pound for oat grass or silage would be a maximum figure.

Table 22. Summary of feed costs and profits.

Lot no.	Per cent mortality	Av. no. hens	Per cent egg production: Av. no. hens	Orig. no. hens	Total eggs	No. eggs per hen: Av.	Orig.	Av. egg price cents	Egg receipts	Receipts per hen	Lbs. feed per hen	Feed cost per hen	Profit over feed cost per hen
I	46	78.40	48.2	37.8	13749	170.1	137.5	16.3	$184.80	$2.27	80.43	$1.87	.400
II	47	77.51	48.2	36.0	12745	163.1	127.6	16.3	169.19[1]	2.15	77.01	1.39	.765
III	52	74.90	41.1	30.8	11210	149.5	112.1	16.3	151.16	2.00	72.57	1.59	.406
IV	81	51.80	41.8	21.5	7842	159.6	78.4	16.3	107.16	2.12	74.64	1.64	.480

1. Grass eggs discounted 3.5 cents per dozen (67.6 doz. x 3.5 cents per doz. equals $2.36).

In Table 22 a complete summary of the laying year is presented. It can readily be observed that lot II, the grass and silage fed group, produced eggs at a much lower unit cost which resulted in an increased profit of 28.5 cents per bird over all other lots. Considering the high price for feed and the low egg prices, the results are quite satisfactory.

The Production of "Grass Eggs"

It must be mentioned, however, that the feeding of greens is not always beneficial, and may produce detrimental results. Such was the case when the birds in lot II consumed too much silage causing the production of "grass eggs". The feeding of silage started gradually on November 16, 1937, and increased each day until by November 20, when 4 pounds per 100 birds was fed. On November 27, grass eggs were observed in 25.9 per cent of the eggs laid that day. In all probability other colored eggs had been laid previously. The number of grass eggs continued although the percentage was quite variable throughout the period silage was fed and stopped completely when immature oat grass was substituted starting April 24, 1938. All eggs produced by lot II during that period were candled and graded for color; later most of the eggs were broken out so as to check the candling obser-

vations. A total of 926 eggs were classed as green by candling, but when broken out, 113 were observed to be free or almost free from green color. Whether detection of grass eggs is more accurate by candling as compared to breaking out, is still a question. In this problem, the candling was done daily while the breaking was done at about two week intervals which may account for the difference in the results from the two methods. From table 23, it can be seen that over 50 per cent of all eggs laid by 6 hens during the period were green, and that 87 per cent of the eggs laid by 2 hens were green. A total of 30.1 per cent of all eggs laid by hens giving green eggs or 13.3 per cent of all eggs laid by all the hens in the lot, were green in varying degrees. When the worst offending birds were examined 30 minutes after feeding silage, their crops seemed to contain a larger quantity of silage than other hens which produced no green eggs. It would appear from this test that the effect was quantitative rather than qualitative, but as yet the exact cause of the variability has not been determined, although many attempts are being made to do so. A total of 813 green yolked eggs (broken out observations) were laid, which when discounted at 3.5 cents per dozen amounted to $2.36 for the entire 155 days or .00018 cents per hen per day. This amount was deducted from the gross returns leaving a net egg receipt of $169.19.

Table 23. Results of feeding oat grass silage to White Leghorn pullets for 155 days from Nov. 27, 1937 to April 24, 1938[1].

Hen No.	Total number eggs	Number green eggs	Percentage green eggs
4322	91	14	15.3
4324	80	10	12.5
4329	76	12	15.9
4331	33	2	6.0
4333	58	13	22.4
4338	101	8	8.0
4339	94	1	1.1
4340	62	1	1.6
4348	122	5	4.1
4351	102	11	10.7
4352	63	29	46.0
4353	35	11	31.4
4356	108	29	26.8
4357	120	12	10.0
4366	126	36	28.6
4367	62	7	11.3
4374	63	41	65.0
4378	109	95	87.0
4379	130	51	39.2
4384	99	4	4.0
4387	137	96	70.0
4388	86	33	38.3
4390	118	27	23.0
4394	117	27	23.0
4397	126	3	2.4
4399	116	102	87.9
4401	72	12	16.6
4405	52	31	59.6
4409	111	37	33.3
4413	56	32	57.1
4415	23	4	17.8
4416	54	3	5.5
4419	104	27	26.0
4420	118	67	56.8
Floor	33	33	
Total	3075	926	30.1

1. Candling observations were made on all eggs laid. Results above are from hens that laid green eggs.

Carotene and Xanthophyll Content of Eggs

Samples of all eggs produced the first day of each of three months, March, April and May, were broken out and analyzed by the Chemistry Department for carotene and xanthophyll content.

Observations from Table 24 show an increase in xanthophyll content and thus the color of egg yolks, during the period samples were taken. Carotene content increased in all determinations except the May sample for lot II. Pullets fed on fresh cereal grasses produced darker egg yolks, followed in order with dehydrated grasses and dehydrated alfalfa respectively.

Table 24. Carotene and xanthophyll content of eggs[1].

Date	Lot	Carotene Mg. per 100 gms.	Xanthophyll Mg. per 100 gms.
March 1, 1938	I	.2024	1.66
	II	.2720[2]	2.40
	III	.0800	.85
	IV	.0500	.64
April 1, 1938	I	.2330	1.756
	II	.3950[2]	3.155
	III	.0848	1.005
	IV	.0662	1.059
May 1, 1938	I	.3260	2.23
	II	.3020[2]	3.42
	III	.1440	1.12
	IV	.0930	1.30

1. From chemical determinations made by Dr. W. J. Peterson for Prof. L. F. Payne, spring 1938.

2. Oat plant silage was fed previous to samples taken on March 1 and April 1, and fresh spring oats were fed two weeks before the May 1 sample was taken.

Body Weight

Table 25 shows that body size of hens in all lots increased from the twenty-fourth to the forty-sixth week, the average increase being 30.2 per cent, and then decreased 3.5 per cent during the next 30 weeks. Although the hens fed on grass with no milk (lot II) did not attain as great a size, they seemed to maintain their body weight better during the

last 30 weeks than the other lots.

Table 25. Average body weights of remaining pullets in each lot in grams.

Lot No.	24 wk.	46 wk.	Percentage increase	76 wk.	Percentage decrease
I	1479.5	1962.6	32.6	1903.4	3.1
II	1447.1	1853.2	28.0	1823.4	1.6
III	1482.3	1987.1	34.0	1907.3	4.5
IV	1463.2	1854.0	26.8	1762.3	5.2
Average	1469.3	1914.2	30.2	1949.1	3.5

Adult Mortality

The adult mortality for all lots was extremely high. Mortality in lots I, II, III and IV were 46, 47, 52, and 81 per cent, respectively. There were too many variables in the control lot to indicate what might have been the cause of the excessive mortality. Table 26 indicates the adult mortality by four week periods for all 4 lots. Deaths appear to be distributed fairly uniform throughout the year.

Table 26. Mortality by periods, 1937-38

Lot:	Periods 1	2	3	4	5	6	7	8	9	10	11	12	13	Tot. dead:	Total housed:	% dead
I:	0	4	3	3	3	5	7	5	4	1	7	1	3	46:	100	46
II:	0	4	4	2	5	7	3	5	8	4	4	2	1	47:	100	47
III:	0	5	3	6	5	2	7	6	4	2	6	4	2	52:	100	52
IV:	3	13	8	15	7	6	5	4	6	2	7	4	1	81:	100	81
Tot:	3	26	18	26	18	20	22	20	22	9	24	11	7	226:	400	226
%	.75	6.5	4.5	6.5	4.5	5.0	5.5	5.0	5.5	2.25	6.0	2.75	1.75	:		56.5

A check on the autopsy record reveals a preponderance of deaths due to leucosis and associated diseases, followed in order by pullorum, ovarian disorders, cannibalism, chronic coccidiosis, tapeworms and many others. Practically every type of poultry ailment was recorded. Most birds had one or more ailments although only one disorder (that likely to cause death) appears on the record in table 27. Due to the extremely high mortality the validity of the entire experiment is questionable.

Flock Depreciation

Table 28 indicates the effect on the profit per lot when depreciation due to mortality is considered. The birds were valued at 75 cents at the start and 50 cents at the close of the laying year or a net loss of 25 cents per bird even if all survived. The high mortality especially in lot IV resulted in a big loss. When this figure was added to the feed costs per lot and the egg receipts deducted, a loss in net receipts was obtained in all four groups. Lot II with a $-4.01 was low followed with lots I, III and IV which had -19.30, -28.39 and -51.49, respectively.

Table 27. Mortality, with autopsy - 1937-38.

Type of disease	Lot I	Lot II	Lot III	Lot IV	Total	Per cent	Total	Per cent
Leucosis and leukemia								
Leucosis	22	19	29	31	101	44.7		
Paralysis	2	3	7	6	18	7.9	120	53.1
Tumor	0	0	0	1	1	.4		
Ovarian disorders								
Ruptured oviduct	3	3	2	6	14	6.1		
Everted oviduct	1	0	0	2	3	1.2	30	13.2
Ruptured ova	0	2	1	1	4	1.7		
Peritonitis	4	2	1	2	9	3.9		
Bacterial infection								
Pullorum	7	11	6	7	31	13.7		
Roup	0	0	0	1	1	.4		
Canker	0	0	0	1	1	.4		
Vent gleet	0	0	0	1	1	.4	40	18.1
Pneumonia	1	0	0	1	2	.9		
Bronchitis	0	0	0	1	1	.4		
Laryngitis	0	0	0	1	1	.4		
Tracheitis	0	1	1	0	2	.9		
Protozoan								
Coccidiosis	2	2	1	1	6	2.6	6	2.6
Worms								
Tapeworms	0	0	0	4	4	1.7	4	1.7
Miscellaneous								
Cannibalism	1	0	2	3	6	2.6		
Ruptured abdomen	1	0	0	0	1	.4		
Enteritis	0	0	1	1	2	.9		
T. B. of liver	1	0	0	0	1	.4		
Fatty deg.of liv.	0	0	0	1	1	.4	26	11.0
Cystic ureter	0	0	0	1	1	.4		
Impaction	0	0	0	1	1	.4		
Ear infection	0	0	0	1	1	.4		
Unknown	1	4	1	6	12	5.3		
Total and percentage dead	46	47	52	81	226	98.9	226	99.7

Table 28. Flock depreciation due to hen mortality.

Lot	No. birds housed	Total cents at 75	No. birds left	Value cents at 50	Depreciation	Feed costs	Feed cost and depreciation	Egg receipts	Profit or loss due to depreciation
I	100	$75.00	54	$27.00	$48.00	$156.10	$204.10	$184.80	$-19.30
II	100	75.00	53	26.50	48.50	116.68	165.18	169.19	- 4.01
III	100	75.00	48	24.00	51.00	128.55	179.55	151.16	-28.39
IV	100	75.00	19	9.50	65.50	93.15	158.65	107.16	-51.49

SUMMARY

1. Cereal grasses, as range crops, appear to have definite values in promoting growth and livability of strong, vigorous pullets at a minimum cost.

2. Pullets during their laying year, fed immature cereal grasses, both in fresh and in ensiled forms, gave larger net return per bird and had about as satisfactory livability and hatchability as pullets supplied dried cereal grasses plus condensed butter milk (Creenmelk), or birds fed on dehydrated alfalfa leaf meal plus condensed butter milk.

3. The differences in egg production between all four lots were great enough to be significant, according to the statistical methods applied, in favor of lot I over II, III and IV, lot II over III and lot IV over III.

4. The feeding of molasses oat grass silage resulted in the production of "grass eggs" from a few hens, the cause for which has not been determined.

5. Darker yolk color was observed in eggs from hens fed on fresh and ensiled cereal grasses followed in order by dehydrated cereal grass and dehydrated alfalfa leaf meal.

6. Pullets reared on a used alfalfa range were more susceptible to disease and thus had greater mortality than pullets reared on an unused cereal grass range.

7. Pullets reared on a cereal grass range produced larger eggs than pullets reared on an alfalfa range.

8. Pullets fed on Greenmalk and grass during their first laying year did not have as severe a winter pause and were also able to overcome it in less time than were pullets fed on alfalfa leaf meal.

9. High mortality from numerous causes and more than one variable in the control pen of this experiment, make further studies advisable before final conclusions can be made.

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ACKNOWLEDGMENT

The author is deeply grateful for the valuable suggestions and assistance of Professor L. F. Payne throughout the entirety of this problem, to Miss Jocelyn Parsons for her help in compiling the data, to the Department of Bacteriology for its diagnostic work, and to the Department of Chemistry for chemical analyses of feedstuffs.